Republic of South Africa

EDICT OF GOVERNMENT

In order to promote public education and public safety, equal justice for all, a better informed citizenry, the rule of law, world trade and world peace, this legal document is hereby made available on a noncommercial basis, as it is the right of all humans to know and speak the laws that govern them.

SANS 10142-2 (2009) (English): The wiring of premises Part 2: Medium-voltage installations above 1 kV a.c. not exceeding 22 kV a.c. and up to and including 3 000 kW installed capacity

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Edition 2

SWAZILAND NATIONAL STANDARD

The wiring of premises

Part 2: Medium-voltage installations above 1 kV a.c. not exceeding 22 kV a.c. and up to and including 3 000 kW installed capacity

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Table of changes

Clause Changed	Date	Change
Note 2	2011	replace "*Eskom or municipalities*" with "*Local Supply Authority*".
Clause 3.8.5	2011	Replace "*as defined in legislation*" with "*in relation to plant or machinery, means the person who uses plant or machinery for his own benefit or who has the right of control over the use of plant or machinery, but does not include a lessor of, or any person employed in connection with, that or machinery*;"
Clause 3.8.6	2011	Replace "*as defined in legislation*" with "the person who has the sole right of control over the use of plant or machinery".
Clause 4.1.1	2011	replace "*South Africa*" with "*Swaziland*".

NATIONAL FOREWORD

This Swaziland National Public Review Draft Standard was prepared by Technical committee *SWASA/TC 33 Solar and Electrical in* accordance with procedures of the Swaziland Standards Authority, in compliance with Annex 3 of the WTO/TBT Agreement. This national public review draft standard is a modified implementation of SANS 10142-2:2009 and is adopted with the permission of the South African Bureau of Standards (SABS).

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The wiring of premises

Part 2:

Medium-voltage installations above 1 kV a.c. not exceeding 22 kV a.c. and up to and including 3 000 kW installed capacity

1 Scope

1.1 This part of SANS 10142 covers requirements for the design, erection and modification of specific, fixed, medium-voltage electrical installations in distribution systems between the point of control and the point of consumption, with nominal voltages above 1 kV a.c. not exceeding 22 kV a.c. and up to and including 3 000 kW installed capacity, so as to provide safe and proper functioning for the use intended.

1.2 Specific medium-voltage electrical installations include

a) residential complexes,

b) commercial complexes,

c) industrial complexes, and

d) installations with regard to agriculture.

NOTE 1 Medium-voltage electrical installations include generators, transformers, switchgear, auxiliary equipment and circuits.

NOTE 2 This part of SANS 10142 does not cover distribution systems operated by Local Supply Authority.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document applies. Information on currently valid national and international standards can be obtained from the SABS Standards Division.

2.1 South African standards

SANS 97, Electric cables – Impregnated paper-insulated metal-sheathed cables for rated voltages 3,3/3,3 kV to 19/33 kV (excluding pressure assisted cables).

SANS 182-1, Conductors for overhead electrical transmission lines – Part 1: Copper wires and stranded copper conductors.

SANS 182-2, Conductors for overhead electrical transmission lines – Part 2: Stranded aluminium conductors.

SANS 182-3, Conductors for overhead electrical transmission lines – Part 3: Aluminium conductors, steel reinforced.

SANS 555, Unused and reclaimed mineral insulating oils for transformers and switchgear.

SANS 780, Distribution transformers.

SANS 808, Cable glands for use on flameproof enclosures.

SANS 1029, Miniature substations.

SANS 1037, Standard transformer bushings.

SANS 1063, Earth rods, couplers and connections.

SANS 1213, Mechanical cable glands.

SANS 1339, Electric cables – Cross-linked polyethylene (XLPE) insulated cables for voltages 3,8/6,6 kV to 19/33 kV.

SANS 1371, Ceramic hollow insulators for standard transformer bushings.

SANS 1411-1, Materials of insulated electric cables and flexible cords – Part 1: Conductors.

SANS 1507-1, Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) – Part 1: General.

SANS 1507-2, Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) – Part 2: Wiring cables.

SANS 1507-3, Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) – Part 3: PVC Distribution cables.

SANS 1507-4, Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) – Part 4: XLPE Distribution cables.

SANS 1507-5, Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) – Part 5: Halogen-free distribution cables.

SANS 1507-6, Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) – Part 6: Service cables.

SANS 1520-1, Flexible electric trailing cables for use in mines – Part 1: Low-voltage (640/1 100 V and 1 900/3 300 V) cables.

SANS 1713, Electric cables – Medium-voltage aerial bundled conductors for voltages from 3,8/6,6 kV to 19/33 kV.

SANS 1874, Metal-enclosed ring main units for rated a.c. voltages above 1 kV and up to and including 24 kV.

SANS 1885/NRS 003, AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 36 kV.

SANS 10108, The classification of hazardous locations and the selection of apparatus for use in such locations.

SANS 10198-1, The selection, handling and installation of electric power cables of rating not exceeding 33 kV – Part 1: Definitions and statutory requirements.

SANS 10198-2, The selection, handling and installation of electric power cables of rating not exceeding 33 kV – Part 2: Selection of cable type and methods of installation.

SANS 10198-3, The selection, handling and installation of electric power cables of rating not exceeding 33 kV – Part 3: Earthing systems – General provisions.

SANS 10198-4, The selection, handling and installation of electric power cables of rating not exceeding 33 kV – Part 4: Current ratings.

SANS 10198-5, The selection, handling and installation of electric power cables of rating not exceeding 33 kV – Part 5: Determination of thermal and electrical resistivity of soil.

SANS 10198-6, The selection, handling and installation of electric power cables of rating not exceeding 33 kV – Part 6: Transportation and storage.

SANS 10198-7, The selection, handling and installation of electric power cables of rating not exceeding 33 kV – Part 7: Safety precautions.

SANS 10198-8, The selection, handling and installation of electric power cables of rating not exceeding 33 kV – Part 8: Cable laying and installation.

SANS 10198-9, The selection, handling and installation of electric power cables of rating not exceeding 33 kV – Part 9: Jointing and termination of extruded solid dielectric-insulated cables up to 3,3 kV.

SANS 10198-10, The selection, handling and installation of electric power cables of rating not exceeding 33 kV – Part 10: Jointing and termination of paper-insulated cables.

SANS 10198-11, The selection, handling and installation of electric power cables of rating not exceeding 33 kV – Part 11: Jointing and termination of screened polymeric-insulated cables.

SANS 10198-12, The selection, handling and installation of electric power cables of rating not exceeding 33 kV – Part 12: Installation of earthing system.

SANS 10198-13, The selection, handling and installation of electric power cables of rating not exceeding 33 kV – Part 13: Testing, commissioning and fault location.

SANS 10199, The design and installation of earth electrodes.

SANS 10200, Neutral earthing in medium voltage industrial power systems.

SANS 10280, Overhead power lines for conditions prevailing in South Africa.

SANS 10292, Earthing of low-voltage (LV) distribution systems.

SANS 10313, Protection against lightning – Physical damage to structures and life hazard.

SANS 17025/ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories.

SANS 60044-1/IEC 60044-1, Instrument transformers – Part 1: Current transformers.

SANS 60044-2/IEC 60044-2, Instrument transformers – Part 2: Inductive voltage transformers.

SANS 60044-5/IEC 60044-5, Instrument transformers – Part 5: Capacitor voltage transformers.

SANS 60060-1/IEC 60060-1, High-voltage test techniques – Part 1: General definitions and test requirements.

SANS 60076-10/IEC 60076-10, Power transformers – Part 10: Determination of sound levels.

SANS 60079/IEC 60079 (all parts), Electrical apparatus for explosive gas atmospheres.

SANS 60099-4/IEC 60099-4, Surge arresters – Part 1: Metal-oxide surge arresters without gaps for a.c. systems.

SANS 60137/IEC 60137, Insulated bushings for alternating voltages above 1 000 V.

SANS 60265-1/IEC 60265-1, High-voltage switches – Part 1: Switches for rated voltages above 1 kV and less than 52 kV.

SANS 60282-1/IEC 60282-1, High-voltage fuses – Part 1: Current-limiting fuses.

SANS 60282-2/IEC 60282-2, High-voltage fuses – Part 2: Expulsion fuses.

SANS 60305/IEC 60305, Insulators for overhead lines with a nominal voltage above 1 000 V – Ceramic or glass insulator units for a.c. systems – Characteristics of insulator units of the cap and pin type.

SANS 60383-1/IEC 60383-1, Insulators for overhead lines with a nominal voltage above 1 000 V – Part 1: Ceramic or glass insulator units for a.c. systems – Definitions, test methods and acceptance criteria.

SANS 60383-2/IEC 60383-2, Insulators for overhead lines with a nominal voltage above 1 000 V – Part 2: Insulator strings and insulator sets for a.c. systems – Definitions, test methods and acceptance criteria.

SANS 60502-4/IEC 60502-4, Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1,2 kV) up to 30 kV (Um = 36 kV) – Part 4: Test requirements on accessories for cables with rated voltages from 6 kV (Um = 7,2 kV) up to 30 kV (Um = 36 kV).

SANS 60529/IEC 60529, Degrees of protection provided by enclosures (IP Code).

SANS 60694/IEC 60694, Common specifications for high-voltage switchgear and controlgear standards.

SANS 60815/IEC 60815, Guide for the selection of insulators in respect of polluted conditions.

SANS 60865-1/IEC 60865-1, Short-circuit currents – Calculation of effects – Part 1: Definitions and calculation methods.

SANS 60947-6-2/IEC 60947-6-2, Low-voltage switchgear and controlgear – Part 6-2: Multiple function equipment – Control and protective switching devices (or equipment) (CPS).

SANS 61230/IEC 61230, Live working – Portable equipment for earthing or earthing and short-circuiting.

SANS 61241-1/IEC 61241-1, Electrical apparaturs for use in the presence of combustible dust – Part 1: Protection by enclosures “tD”.

SANS 61284/IEC 61284, Overhead lines – Requirements and tests for fittings.

SANS 61481/IEC 61481, Live working – Portable phase comparators for use on voltages from 1 kV to 36 kV a.c.

SANS 62052-11/IEC 62052-11, Electricity metering equipment (a.c.) – General requirements, tests and test conditions – Part 11: Metering equipment.

SANS 62053-21/IEC 62053-21, Electricity metering equipment (a.c.) – General requirements, tests and test conditions – Part 21: Static meters for active energy (classes 1 and 2).

SANS 62271-100/IEC 62271-100, High-voltage switchgear and controlgear – Part 100: Alternating-current circuit-breakers.

SANS 62271-102/IEC 62271-102, High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches.

SANS 62271-105/IEC 62271-105, High-voltage switchgear and controlgear – Part 105: Alternating current switch-fuse combinations.

SANS 62271-200/IEC 62271-200, High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV.

SANS 62271-202/IEC 62271-202, High-voltage switchgear and controlgear – Part 202: High-voltage/low-voltage prefabricated substation.

SANS 62305-3/IEC 62305-3, Protection against lightning – Part 3: Physical damage to structures and life hazard.

2.2 IEC standards

IEC 60055-1, Paper-insulated metal-sheathed cables for rated voltages up to 18/30 kV (with copper or aluminium conductors and excluding gas-pressure and oil-filled cables) – Part 1: Tests on cables and their accessories.

IEC 60055-2, Paper-insulated metal-sheathed cables for rated voltages up to 18/30 kV (with copper or aluminium conductors and excluding gas-pressure and oil-filled cables) – Part 2: General and construction requirements.

IEC 60071-1, Insulation co-ordination – Part 1: Definitions, principles and rules.

IEC 60071-2, Insulation co-ordination – Part 2: Application guide.

IEC/TR 60071-4, Insulation co-ordination – Part 4: Computational guide to insulation co-ordination and modelling of electrical networks.

IEC/TS 60071-5, Insulation co-ordination – Part 5: Procedures for high-voltage direct current (HVDC) converter stations.

IEC 60721 (all parts), Classification of environmental conditions.

IEC 60871-1, Shunt capacitors for a.c. power systems having a rated voltage above 1 000 V – Part 1: General.

IEC/TS 60871-2, Shunt capacitors for a.c. power systems having a rated voltage above 1 000 V – Part 2: Endurance testing.

IEC 60909-0, Short-circuit currents in three-phase a.c. systems – Part 0: Calculation of currents.

IEC/TR 62271-303, High-voltage switchgear and control gear – Part 303: Use and handling of sulphur hexafluoride (SF6).

3 Definitions

For the purposes of this document, the following definitions apply.

3.1 General definitions

3.1.1
highest voltage for equipment
highest phase-to-phase r.m.s. voltage for which the equipment is designed in respect of its insulation as well as other characteristics which relate to this voltage in the relevant equipment standards

3.1.2
licensed supplier
body that has been licensed by the relevant authority to supply and sell electricity

3.1.3
live part
conductor or conductive part intended to be energized in normal use

NOTE This includes a neutral conductor, but, by convention, not a PEN conductor.

3.1.4
MV point of consumption
point of outlet, or the supply terminal of machinery which is not connected to a point of outlet and which converts electrical energy to another form of energy above 1 000 V a.c., provided that, in the case of machinery that has been installed for any specific purpose as a complete unit, the point of consumption is the supply terminal that has been provided on the unit of machinery for that purpose

3.1.5
MV point of outlet
termination of an MV electrical installation, which has been provided for connecting any electrical machinery without the use of a tool, provided that no connection to a busbar is deemed to be a point of outlet

3.1.6
nominal voltage
suitable approximate value of phase-to-phase voltage used to designate or identify a system

3.1.7
point of control
point at which the consumer has access to a device to switch off the electrical installation from the electricity supplied from the point of supply

3.1.8
point of supply
point at which a licensed supplier supplies electricity to any premise

NOTE Where the supplier's cable crosses the boundary of the user, the user's responsibility starts at the boundary.

3.1.9
power distribution equipment
equipment used for purposes such as generation, conversion, transmission, distribution and utilization of electrical energy

NOTE Such equipment includes machines, transformers, apparatus, measuring instruments, protective devices, equipment for wiring systems, appliances.

3.2 Installation definitions

3.2.1
busbar
in a substation, the assembly system necessary to make a common connection for several circuits

EXAMPLE Three busbars for a three-phase system.

3.2.2
catchment tank
tank for collecting the leakage liquids, rainwater etc. for one or more transformers or other equipment

3.2.3
enclosed electrical operating area
room or location for operation of an electrical installation and equipment to which access is intended to be restricted to skilled or instructed persons or to lay personnel under the supervision of skilled or instructed persons by, for example, opening of a door or removal of a barrier only by the use of a key or tool, and which is clearly marked by appropriate warning signs

NOTE Such an area includes, for example, enclosed switchgear and distribution installations, transformer enclosures, switchgear bays or cubicles, distribution installations in sheet metal housings or in other enclosed installations.

3.2.4
feeder
electric line that originates at a main substation and supplies one or more secondary substations, or one or more branch lines, or any combination of these two types of installation

3.2.5
sump
receptacle that is intended to receive the insulating oil of a transformer or of other equipment in the case of leakage

3.2.6
transient overvoltage
short duration overvoltage of a few milliseconds, or less, oscillatory or non-oscillatory, usually highly damped

3.3 Definitions on types of installation

3.3.1
indoor installation
electrical installation in a building or room in which the equipment is protected against the weather

3.3.2
outdoor installation
electrical installation that is outdoors and fenced-in, or a mini-substation, or a pole-mounted installation, or a ring main unit

3.4 Definitions on safety measures against electric shock

3.4.1
barrier
part that provides protection against direct contact from any usual direction of access

3.4.2
enclosure
part that provides protection of equipment against certain external influences and, in any direction, protection against direct contact

3.4.3
obstacle
part that prevents unintentional direct contact, but does not prevent direct contact by deliberate action

3.4.4
protection against direct contact
measure that prevents a person (part(s) of a person's body, or a person with an object), when reaching the danger zone, from coming into dangerous proximity of live parts or those parts that could carry a dangerous shock hazard voltage

3.5 Clearances definitions

3.5.1
barrier clearance
smallest permissible distance between a barrier and live parts or those parts that might become subject to a dangerous shock hazard voltage

3.5.2
clearance
distance between two conductive parts along a string stretched the shortest way between these conductive parts

3.5.3
danger zone
area limited by the minimum clearance around live parts without complete protection against direct contact

NOTE Infringing the danger zone is considered the same as touching live parts.

3.5.4
minimum clearance
smallest permissible distance in air between live parts or between live parts and earth

3.5.5
minimum height
smallest permissible vertical distance between accessible surfaces and live parts without protection against direct contact or against those parts that might become subject to a dangerous shock hazard voltage

3.5.6
minimum safety clearance
smallest permissible distance in air, in which a person may encroach on, in person or with an object

3.6 Control and protection definitions

3.6.1
surge protection
clamping of a prospective transient overvoltage to below the basic insulation level of the system by means of a surge arrester

3.7 Earthing definitions

3.7.1
earth
ground
conductive mass of the earth, the electric potential of which, at any point, is conventionally taken as equal to zero

3.7.2
earth electrode
ground electrode
conductor or group of conductors in intimate contact with, and providing, an electrical connection to earth

3.7.3
earth fault
fault that is caused by a conductor which is connected to earth or by the insulation resistance to earth which becomes less than a specified value

NOTE Earth faults of two or several phase conductors of the same system at different locations are designated as double or multiple earth faults.

3.7.4
earth fault current
IF
current that flows from the main circuit to earth or to earthed parts at the fault location (earth fault location)

NOTE In the case of a single earth fault this is

a) in a system with isolated neutral, the capacitive earth fault current,

b) in a system with resonant earthing, the earth fault residual current,

c) in a system with low-impedance neutral earthing, the line-to-earth short-circuit current.

3.7.5
earth impedance
ZE
<earthing system>
impedance between a point of the earthing system and reference earth

NOTE The impedance to earth is determined by the directly connected earth electrodes and also by connected overhead earth conductors and conductors buried in earth of overhead lines, by connected cables with earth electrode effect and by other earthing systems that are conductively connected to the relevant earthing system by conductive cable sheaths, shields, PEN conductors, or in another way.

3.7.6
earthing
total of all means and measures for earthing

3.7.7
earthing conductor
grounding electrode conductor
protective conductor that connects the main earthing terminal or bar to the earth electrode

NOTE Where the connection between part of the installation and the earth electrode is made through a disconnecting link, disconnecting switch, surge arrester counter, surge arrester control gap, etc., then only that part of the connection permanently attached to the earth electrode is an earthing conductor

3.7.8
earthing system
grounding system
arrangement of connections and devices necessary to earth equipment or a system separately or jointly

3.7.9
earth potential rise
EPR
voltage between an earthing system and reference earth

3.7.10
earth resistance
RE
<earth electrode>
resistance between the earth electrode and the reference earth

3.7.11
earth rod
earth electrode that consists of a metal rod driven into the ground

3.7.12
exposed conductive part
conductive part of electrical equipment that can be touched and is normally not live, but which may become live under fault conditions

3.7.13
extraneous conductive part
conductive part that does not form part of the electrical installation and is liable to introduce a potential, generally the earth potential

3.7.14
PEN conductor
earthed conductor that combines the functions of both the protective conductor and the neutral conductor in a low-voltage system

3.7.15
potential
voltage between an observation point and reference earth

NOTE In certain cases, the impedance of the person in contact with these parts may appreciably influence the value of the touch voltage.

3.7.16
reference earth
remote earth
remote ground
earth electrode connected to equipment, and located at such a distance from this equipment that it is independent of any other earth electrode close to this equipment

3.7.17
soil resistivity
measure of the resistance of one cubic metre of soil

NOTE Soil resistivity is expressed in ohm metres (Ω·m).

3.7.18
step voltage
US
part of the earth potential rise due to an earth fault that can be picked up by a person with a step-width of 1 m

3.8 Person definitions

3.8.1
contractor's representative
person duly authorized to act on behalf of the contractor appointed to perform the electrical design, or the electrical construction and installation, or commissioning (or both) of the MV electrical installation

3.8.2
instructed person
person adequately advised or supervised by skilled persons to enable him or her to perceive risks and to avoid hazards electricity can create
[IEC 60050]

3.8.3
registered person
person registered with the relevant authority and who is competent to perform work in accordance with this part of SANS 10142

3.8.4
skilled person
person with relevant education and experience to enable him or her to perceive risks and to avoid hazards which electricity can create
[IEC 60050]

3.8.5
user
in relation to plant or machinery, means the person who uses plant or machinery for his own benefit or who has the right of control over the use of plant or machinery, but does not include a lessor of, or any person employed in connection with, that or machinery;

3.8.6
user's designated person
the person who has the sole right of control over the use of plant or machinery

3.9 Abbreviations

BIL: basic insulation level

CT: current transformer

HV: high voltage

MV: medium voltage

4 Compliance

4.1 Statutory requirements

4.1.1 In accordance with Swaziland legislation, the registered person is required to ensure that a fixed MV electrical installation is designed and constructed in accordance with the relevant provisions.

4.1.2 For the appointment of competent persons for the supervision, operation and maintenance of machinery, see annex A.

4.2 Safety Report

The MV Installation Safety Report (see annex B) shall be completed in terms of the specific requirements as indicated.

4.3 Applicable standards

Table 1 gives a list of commodities, the applicable compulsory safety standards and recommended performance specifications. The commodities given in column 1 shall comply with the standards given in column 3 and it is recommended as good practice to comply with the specifications given in column 4.

Table 1 — Applicable standards

1	2	3	4
Commodity	**Scope**	**SANS/IEC standard**	**NRS specification** (see Bibliography)
Aerial bundled conductors	6,6 kV to 33 kV	SANS 1713	
Aerial bundled conductors – Fittings for insulated neutral	3,3 kV to 33 kV Strain and suspension fittings		NRS 051
Cables – Extruded insulation	Fixed extruded insulation up to 3,3 kV 1 kV to 30 kV	SANS 1507-1, SANS 1507-2, SANS 1507-3, SANS 1507-4, SANS 1507-5, SANS 1507-6 SANS 60502-4	
Cables (XLPE)	6,6 kV to 33 kV	SANS 1339	
Cables (PILC)	3,3 kV to 33 kV	SANS 97	
Flexible electric trailing cables	640 V to 3,3 kV	SANS 1520-1	
Cable installations	3,3 kV to 33 kV	SANS 10198-1, SANS 10198-2, SANS 10198-3, SANS 10198-4, SANS 10198-5, SANS 10198-6, SANS 10198-7, SANS 10198-8, SANS 10198-9, SANS 10198-10, SANS 10198-11, SANS 10198-12, SANS 10198-13	NRS 034-0, NRS 034-1, NRS 034-2-3, NRS 034-3
Cable glands	Excluding a) entirely non-metallic b) for flameproof use	SANS 1213	
Cable glands (flameproof)	For use on flameproof enclosures (Exd.)	SANS 808	
Cable joints and terminations	XLPE Paper	SANS 60502-4 IEC 60055-1 IEC 60055-2	NRS 053
Conductors: overhead transmission lines	Copper conductors Aluminium conductors Aluminium conductors, steel reinforced	SANS 182-1 SANS 182-2 SANS 182-3	
Overhead lines fittings		SANS 61284	
Overhead line conditions		SANS 10280	

Table 1 *(continued)*

1	2	3	4
Commodity	**Scope**	**SANS/IEC standard**	**NRS specification** (see Bibliography)
Enclosure IP ratings		SANS 60529	
Flameproof enclosures		SANS 60079	
HV fuses		SANS 60282-1 SANS 60282-2	
HV switches		SANS 60265-1	
Switch-fuse combination		SANS 62271-105	
Current transformers		SANS 60044-1	
Voltage transformers		SANS 60044-2 SANS 60044-5	
Power capacitors		IEC 60871-1 IEC/TS 60871-2	
Distribution transformers	3 150 kVA – Maximum 36 kV	SANS 780	NRS 029
Miniature substations	(Prefabricated substations) Miniature substations Miniature substations < 315 kVA	SANS 62271-202 SANS 1029	
Wireways		SANS 61084-1	
Busbar trunking	11 kV		
Bushings		SANS 60137	
Maximum demand meters		SANS 62052-11 SANS 62053-21	
Overhead line design and construction	< 22 kV	SANS 10280	NRS 033
Circuit-breakers	1 kV to 52 kV	SANS 62271-100	
Metal-enclosed switchgear	1 kV to 24 kV	SANS 62271-200 SANS 1885	NRS 003-2
Metal-enclosed ring main units	1 kV to 24 kV	SANS 1874	
AC disconnecting and earthing switches	> 1 000 V	SANS 62271-102	NRS 031
Outdoor distribution cut-outs	Drop-out fuses 22 kV		NRS 035-1
Auto-reclosers and sectionalizers	22 kV		NRS 036-2 and NRS 036-3
Load-break switch-disconnectors	Pole mounted > 1 000 V < 36 kV		NRS 046
Dust-ignition-proof equipment		SANS 61241-1	
Earth leakage circuit-breakers			
Earthing of earth electrodes		SANS 10199	
Earthing: Neutral earthing in MV industrial power systems		SANS 10200	
Earth rods		SANS 1063	

Table 1 *(concluded)*

1	2	3	4
Commodity	**Scope**	**SANS/IEC standard**	**NRS specification**
Earth wire (conductors)		SANS 1411-1	
Portable earthing gear		SANS 61230	
Surge arresters for MV systems		SANS 60099-4	
Lightning protection		SANS 10313	
Protective relays		SANS 60947-6-2	
Insulators	Overhead lines > 1 000 V Hollow insulators for HV equipment Standard transformer bushings Ceramic bushings Line insulators Selection of insulators in respect of pollution conditions	 SANS 1037 SANS 1371 SANS 60305 SANS 60383-1 and SANS 60383-2 SANS 60815 SANS 60265-1	
High-voltage operating regulations	Under development		

4.4 Notices, labels and rating plates

All notices, labels and rating plates shall be durable and not removable except by determined and deliberate action. The inscriptions shall be legible and indelible. Details on the topics given in column 2 of table 2 can be found in the relevant subclauses in column 1.

Table 2 — Notices, labels and rating plates

1	2
Subclause	**Topic**
5.10.4	Danger signs on boundaries
	First-aid treatment in case of electrocution
5.10.9	Rating plates for transformers
	Indication of high voltage
	First-aid box
5.10.10	Substation notices
5.10.8	Switching equipment
6.12.3	Handling of SF_6 gas

5 Design

5.1 Electrical design

5.1.1 General

5.1.1.1 Installations shall be so constructed that unintentional touching of live parts or unintentional reaching into a dangerous zone near live parts is prevented.

5.1.1.2 Barriers such as solid walls, doors or screens (wire mesh) shall have a minimum height of 1,8 m and shall ensure that no part of the body of a man can reach the dangerous zone near live parts.

5.1.1.3 When protection by enclosure is used, the degree of protection shall comply with the requirements of IP23 as a minimum in the case of indoor and IP54 in the case of outdoor applications.

5.1.1.4 Installations or parts of installations, which can be energized from several sources, shall be arranged so that all sources can be isolated.

5.1.1.5 Where equipment might still carry voltage after complete disconnection from the installation, for example capacitors, devices shall be provided to discharge them.

5.1.2 Prospective short-circuit rating

5.1.2.1 The supply prospective short-circuit rating shall be determined and checked with the licensed supplier.

5.1.2.2 The effect of single-phase and balanced three-phase faults on the installation shall be brought to the attention of the user.

5.1.2.3 The prospective short-circuit rating of the electrical installation shall be calculated so that all associated power distribution equipment is capable of withstanding the highest possible prospective short-circuit currents that might arise. Short-circuit currents in three-phase a.c. systems shall be calculated in accordance with the method given in IEC 60909-0.

5.1.2.4 The effect of short-circuit withstand strength of the installation and overhead conductors shall be calculated in accordance with SANS 60865-1.

5.1.2.5 Installations shall be designed, constructed and erected to withstand the mechanical and thermal effects that result from fault currents.

5.1.2.6 The selection and setting of devices are dependent on the method of neutral earthing and the rated duration of a fault current and shall be determined by taking into consideration the system prospective short-circuit rating, fault switching time and system voltage. If not stated otherwise, the standard value of rated duration of the short-circuit is 1,0 s.

5.1.2.7 Electrical installations shall be designed and installed so that personnel are protected as far as practicable from arc faults during operation. It is recommended that suitable protective clothing be worn when switching takes place (switching should preferably be performed remotely).

5.1.2.8 Where applicable, the requirements of SANS 62305-3 shall apply.

5.1.2.9 Installation requirements shall comply with the fire regulations of the national building regulations and the requirements of the local fire chief.

5.1.2.10 Sumps or catchment tanks shall be arranged so that a fire in one transformer cannot spread to another.

5.1.2.11 For the purpose of avoiding a fire hazard to other transformers or objects, an adequate clearance or fire walls shall be provided (see table 3 for recommended distances).

5.1.3 Overhead structures

The installation shall be dimensioned and designed to avoid danger to persons and damage to property taking into account the type of installation, components to be fitted, and local conditions.

NOTE Since the responsibility for the maintenance of the overhead line from the boundary to the point of control lies with the consumer, cognizance should be taken of obstacles along the route which could cause a hazard.

Table 3 — Minimum clearances for bare overhead MV lines

1	2	3	4	5	6	7
Maximum rated phase-to-phase voltage kV	Minimum clearance m					
	Minimum safety clearance	Above ground, outside townships	Above ground in townships	Above roads in townships, proclaimed roads outside townships and railways	To communi-cation lines, other power lines, or between power lines and cradles	To buildings, poles and structures that do not form part of power lines
1,1 or less	–	4,9	5,5	6,1	0,6	3,0
7,2	0,15	5,0	5,5	6,2	0,7	3,0
12	0,20	5,1	5,5	6,3	0,8	3,0
24	0,32	5,2	5,5	6,4	0,9	3,0
36	0,43	5,3	5,5	6,5	1,0	3,0

5.1.4 Transformers

5.1.4.1 General

5.1.4.1.1 Transformers shall be specified in accordance with table 1.

5.1.4.1.2 Transformers shall be free of chlorofluorocarbons (CFCs).

5.1.4.2 Distribution transformers

5.1.4.2.1 Where distribution transformers are installed, safety devices shall be designed and arranged taking into consideration potential hazards to personnel.

5.1.4.2.2 Where a transformer is installed in a building, doors shall have at least a 60 min fire resistance to retard the spreading of fire to other parts of the building.

5.1.4.2.3 In the case of oil-filled transformers, adequate provision shall be made for containing the oil in the case of leakage or spillage.

5.1.4.2.4 Insulated bushings shall comply with the requirements of SANS 60137.

5.1.4.3 Current transformers

5.1.4.3.1 The rated overcurrent factor, rated burden and core saturation characteristics shall be selected to ensure correct functioning of the protective equipment.

5.1.4.3.2 Measuring devices connected to protective current transformers should be rated to withstand damages that could result from short-circuit currents.

5.1.4.3.3 For the reduction of transient overvoltages on secondary circuits that arise from switching operations, an effective earthed screen may be required between primary and secondary circuits.

5.1.4.3.4 Protection against dangerous overvoltages due to open-circuit secondary windings shall be provided.

5.1.4.4 Voltage transformers

5.1.4.4.1 Voltage transformers shall be suitably rated for voltage, burden and accuracy.

5.1.4.4.2 The secondary side of voltage transformers shall be protected against the effects of short-circuits.

5.1.5 Metal-enclosed switchgear

5.1.5.1 Factory-built, type-tested, medium-voltage switchgear shall be designed, manufactured, type tested and routine tested in accordance with SANS 62271-100.

5.1.5.2 Where safety devices are fitted to reduce the internal switchgear pressure, the switchgear shall be installed in such a way that it will prevent hazard to personnel.

5.1.6 Batteries and chargers

5.1.6.1 DC supply units for batteries shall be provided with indication to monitor voltage, current and charging mode.

5.1.6.2 Batteries shall be installed in properly ventilated rooms or cubicles. Corrosion-resistant, legible signs of suitable size shall be installed in hazardous locations.

5.1.7 Power cables, conductors and accessories

5.1.7.1 Insulated cables shall be selected such that they do not operate beyond their ratings as modified by appropriate de-rating factors for all conditions outside the conditions under which their ratings are quoted. (See the relevant part of SANS 10198.)

5.1.7.2 Where insulated cables cross or are near gas, water or other pipes, an appropriate clearance shall be maintained between the cables and the pipelines. Where this clearance cannot be maintained, contact between the cables and the pipelines shall be prevented.

5.1.7.3 Clearance shall be maintained between cables and telecommunication installations in accordance with SANS 61230.

5.1.7.4 Cables shall be suitably protected and derated where installed in proximity to heat and radiating sources, and protective measures shall be applied.

5.1.7.5 Provision shall be made to allow for the expansion and contraction of conductors caused by temperature variations.

5.1.7.6 Joints between conductors and connections between conductors and equipment shall be chemically and mechanically stable. Joints shall be suitable for the application, and shall fully comply with the manufacturer's instructions for installation and use. The temperature rise of a connection between conductors and switchgear in service shall not exceed the values specified in SANS 60694.

5.1.7.7 The type of cable shall suit particular applications with regard to fire risk, solar radiation and other detrimental environmental conditions (see the manufacturer's recommendations).

5.1.7.8 Where a feeder consists of a number of single-core cables run in a trefoil configuration, they shall be arranged in a symmetrical form to balance impedances, and shall be appropriately clamped or strapped to maintain the trefoil configuration.

5.1.8 Surge arresters

5.1.8.1 Where overhead line supply is utilized, surge protection shall be installed at all terminations and shall comply with SANS 60099-4.

5.1.8.2 Surge arresters shall be designed or positioned in such a way as to provide personnel safety in the case of an explosion of the housing or operation of the pressure-relief device.

5.1.9 Overhead isolators, sectionalizers and reclosers

5.1.9.1 Isolating equipment and fuses shall be so arranged that they can be operated without danger. Isolating equipment shall be lockable if it can be operated by hand from ground level.

5.1.9.2 The operating rods shall be compliant with the relevant standard. Safe phase-to-phase connection and earthing of the overhead line shall be possible in accordance with the requirements of SANS 61230.

5.1.10 Generator sets

The degree of protection against the ingress of objects, dust and water shall be chosen in accordance with the special climatic and environmental conditions at the site of installation. The protection rating shall be a minimum of IP54 in the case of an outdoor application and at least IP4X in the case of an indoor installation.

5.1.11 Power capacitors

5.1.11.1 Power capacitors shall comply with IEC 60871-1 and IEC/TS 60871-2.

5.1.11.2 Resonance shall be considered.

5.1.11.3 Facilities shall be provided with power capacitors for safe and automatic discharge, and a notice to this effect shall be attached to the control equipment. A further notice to warn against dangerous voltages shall be attached to the control equipment.

5.1.11.4 The short-circuiting and earthing facilities provided for a capacitor bank shall take into account the interconnection of units within the bank, the discharge resistors and the type of protection.

5.1.11.5 Voltage increase caused by inductive reactance connected in series such as damping reactors or filters' circuits, should be considered when the voltage and current rating of the power capacitors are being selected.

5.1.12 Outdoor insulators

5.1.12.1 Outdoor insulators shall comply with the requirements in table 1.

5.1.12.2 Insulators shall be selected for the mechanical and electrical requirements of the installation.

5.1.12.3 The minimum specific creepage distance of insulators shall comply with SANS 60815.

5.1.12.4 Insulator profile requirements for the performance of outdoor insulators in polluted or heavy wetting conditions shall be considered.

5.1.13 Insulation co-ordination

Where required, insulation co-ordination shall comply with the relevant part of IEC 60071.

5.2 Mechanical design

5.2.1 Overhead lines

Overhead electrical power lines shall comply with SANS 10280.

5.2.2 Other structures and foundations

5.2.2.1 Equipment and supporting structures, including foundations, shall withstand the anticipated mechanical stresses.

5.2.2.2 All loads, such as dead loads, tension loads, erection loads, ice loads and wind loads are normal loads acting on structures which shall be considered when the structures and foundations are being designed.

5.2.2.3 The resulting load on flexible conductors, rigid busbars and conductors shall be taken into account in regions where icing can occur. Ice coatings based on criteria given in SANS 60694 may be assumed.

5.2.2.4 Supporting structures in substations shall accommodate switching forces.

5.2.2.5 The mechanical effects of a short-circuit shall be determined in accordance with SANS 60865-1.

5.2.2.6 A structure with tension insulator strings shall be designed to withstand the loss of conductor tension that results from breakage of the insulator or the conductor that gives the most unfavourable load case.

5.2.2.7 The effects of vibration such as vibration caused by wind, electromagnetic stresses and traffic shall be considered.

5.3 Earthing

5.3.1 The design of the earthing system shall comply with SANS 10199.

5.3.2 The earthing system shall limit step and touch potentials to safe limits, and shall be performed in accordance with SANS 10292

5.3.3 The earthing system, its components and bonding conductor shall be capable of distributing and discharging the fault current without exceeding thermal and mechanical design limits.

5.3.4 The earthing system shall be designed to maintain its integrity for its expected lifetime with due allowance for corrosion and mechanical constraints.

5.3.5 The earthing system shall be designed to prevent a touch potential under fault conditions exceeding 50 V.

5.3.6 Earthing of MV and LV systems in close proximity shall be carried out in accordance with SANS 10292. The MV and LV earthing systems shall be interconnected if the LV system is totally confined within a substation or miniature substation.

5.3.7 If an earth resistance of less than 1 Ω cannot be achieved and maintained, the MV and LV earthing shall be separately installed in accordance with the requirements of SANS 10292.

5.3.8 A dedicated MV earth bar shall be installed in a substation building. The continuity of the earth bar shall not be impaired when an earth conductor is being disconnected.

5.4 Buildings and enclosures

5.4.1 Buildings shall comply with national building codes and fire regulations. Where such national standards do not exist, the guidelines in 5.4.2 to 5.4.5 may be used.

5.4.2 Substation buildings shall comply with the requirements of the Electrical Machinery Regulations .

5.4.3 No exposed liquid, gas or effluent pipes with operational or service openings shall be installed inside substation buildings.

5.4.4 A barrier shall separate the MV and LV equipment that are installed in the same building. The MV bushing connections shall be sealed and insulated.

5.4.5 Notwithstanding the ventilation provided, rooms that contain open type lead batteries shall be considered as locations with corrosive environments. Walls, ceilings and floors shall comply with the requirements for protection against corrosion and gaseous products. Means shall be provided to prevent corrosive substances from entering any drainage systems (see also the requirements for hazardous locations in SANS 10108).

5.5 Clearance distances

5.5.1 General

5.5.1.1 The values of minimum clearances N are given in table 4.

5.5.1.2 In the case of lightning impulse withstand voltage, clearances given in table 4 shall apply to both phase-to-phase insulation and phase-to-earth insulation.

Table 4 — Minimum BIL and clearances in air

1	2	3	4	5	
Nominal r.m.s voltage of system U_n	Highest r.m.s voltage for equipment U_m	Rated short duration power-frequency withstand voltage r.m.s	Rated lightning impulse withstand voltage 1,2/50 μs (BIL peak value)	Minimum phase-to-phase and phase-to-earth clearances N	
				Indoor	Outdoor
kV	kV	kV	kV	mm	mm
3,3	3,6	10	40	60	120
6,6	7,1	20	60	90	120
11	12	28	95	160	160
22	24	50	125	220	

5.5.1.3 Under the influence of short-circuit forces, at least 50 % of the minimum clearances in table 4 shall be maintained.

5.5.1.4 If conductors deflect under the influence of wind, the minimum clearances in table 4 shall be maintained.

5.5.1.5 The design of the installation shall be such as to restrict access to danger zones, taking into account the need for operational and maintenance access.

5.5.1.6 External fences shall be provided and, where safety distances cannot be maintained, permanent solid barriers shall be installed.

5.5.2 Barrier clearances (Under consideration)

5.5.3 Power line clearances

The Electrical Machinery Regulations (see foreword), specifies the minimum clearances between bare conductors of power lines and other conductors and objects.

5.6 External fences, walls, access doors and barriers

5.6.1 Unauthorized access to outdoor installations shall be prevented by means of external fences, walls, access doors and barriers.

5.6.2 The height and construction of the fence, wall or barrier shall be adequate to deter access over or under the barrier. The design of the fence, wall or barrier shall take into account any adjacent fence, other structures and trees.

5.6.3 Access doors and gates to MV installations shall be equipped with security locks.

5.6.4 In the case of miniature substations, all access doors and panels shall either be secured from the inside or locked from the outside with a security lock.

5.7 Climatic and environmental conditions

5.7.1 Installations and components shall be designed for operation under the climatic and environmental conditions under which they are intended to operate (see IEC 60721 for environmental classifications).

5.7.2 Installations situated at altitudes higher than 2 000 m shall comply with the resulting additional requirements for such altitudes.

5.7.3 Measures to prevent damage by birds, small animals or micro-organisms shall be taken, such as appropriate choice of materials, the prevention of access, heating, ventilation, etc.

5.8 Electrical protection systems

5.8.1 All installations and their components shall include facilities for the limitation of damage in the event of insulation failure, short circuits or overloads, and to minimize their effect on the remainder of the electrical power supply system and any adjacent facilities whether it be part of the power system or not.

NOTE The protection of people is a consequential function by virtue of the limitation of explosions, arc discharges and fire.

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5.8.2 The facilities can either comprise protection relays (electrical protection) that work in conjunction with circuit-breakers, or the application of HV fuse-links (fuse gear), or a combination of both.

5.8.3 The choice of electrical protection, components and extent of the system applied should be made in relation to

a) the equipment being protected,

b) the degree of selectivity required,

c) the risks associated with failure,

d) the criticality of the supply,

e) the speed with which supply should be restored,

f) when auto-reclosing may or may not be called for, and

g) the need for remote indication or switching.

The design is a cost balance between the protection gear and the protected facilities and the consequences of not minimizing the effects of failure.

5.8.4 Selection of the protection relay components shall take into account

a) load current,

b) maximum and minimum short-circuit currents,

c) the system earthing (earth fault currents), and

d) the need to grade (time selectivity with the upstream supply and downstream installation).

5.8.5 Reference shall be made to the relevant part of SANS 60282 when HV fuse-links to be applied in fuse gear are being selected, specified and chosen.

5.8.6 HV fuse-links in fuse gear for transformer circuit applications shall be selected in accordance with the relevant part of SANS 60282, and operated in accordance with the fuse gear manufacturer's instructions. The main requirements to be considered are given in (a) to (d).

a) The HV fuse-link shall withstand inrush currents.

b) The HV fuse-link current rating shall be at least as high as the permissible overload current of the transformer.

c) Co-ordination between the HV fuse-link and the secondary side protective devices: to achieve the minimum pre-arcing time/current characteristic of the HV fuse-link and the total operating time/current characteristic of the secondary side protective device, as referred to, the primary side should intersect at a higher value of current than the maximum fault current on the load side of the secondary protective device.

d) The pre-arcing current of the HV fuse-link should be as low as possible, i.e. in the 10 s region of the time/current characteristic.

5.8.7 Labels, which indicate the rating and type of recommended fuse-links, shall be provided.

5.8.8 Protective relays should comply with the relevant standards specified in table 1.

5.8.9 HV fuses should comply with the relevant standards specified in table 1.

5.8.10 HV fuses used in switch fuse applications shall comply with SANS 62271-105.

5.9 Audible noise levels

Transformer noise levels shall be within the limits specified by SANS 60076-10.

5.10 Notices and labelling

5.10.1 Signs, boards and notices shall give clear identification and unambiguous marking in order to avoid incorrect operation, human error, accidents etc. during operation and when maintenance is being carried out. Signs, boards and notices shall be made of durable and non-corrodible material and printing shall be in indelible characters.

5.10.2 The operational state of switchgear and controlgear shall be clearly shown by indicators except when the main contacts can clearly be viewed by the operator. Cable terminations and components shall be identified. Relevant details making identification possible in accordance with a wiring list or diagram shall be provided.

5.10.3 In enclosed electrical areas and in industrial buildings an electrical equipment room shall be provided. On the outside of the room and on each access door, signs and notices, which identify the room and warn of hazards, shall be provided.

5.10.4 All access doors to enclosed electrical operating areas and all sides of outer perimeter fences shall be provided with a triangular warning sign.

5.10.5 Installations with incorporated power capacitors shall be provided with a warning label that indicates the discharge time of the capacitors.

5.10.6 Appropriate safety warning signs in accordance with the national building regulations shall indicate emergency exits.

5.10.7 Warning notices shall be installed at all locations where potentially dangerous fire fighting systems are installed.

5.10.8 Switching equipment shall be fitted with a rating plate that indicates

a) the rated voltage,

b) the rated insulation voltage,

c) the rated current,

d) the rated short-circuit current,

e) the duty cycle, and

f) the type-tested standard.

5.10.9 Transformers shall be fitted with rating plates in accordance with SANS 780.

5.10.10 Substation notices shall be in accordance with legislation .

5.10.11 All notices, labels and rating plates shall be durable and not removable except by determined and deliberate action. The inscriptions shall be legible, indelible and written at least in English.

5.10.12 Ratios, class and burden of current transformers and voltage transformers shall be indicated on each component.

5.10.13 A notice that gives

a) the capacity of the installed transformer,

b) the number of transformers, and

c) the highest voltage

shall be placed at the point of supply and shall be visible to the public.

6 Installation

NOTE Where applicable, layout drawings of the civil or building work (or both) should be approved by the relevant local authority.

6.1 Existing installations

Where construction work involves an existing installation, protective measures shall be taken to ensure the safety of people during fault conditions.

6.2 Installation of a neutral earth and bonding

6.2.1 The earth electrode shall be installed as close as possible to the transformer and shall have an earth resistance not exceeding 1 Ω.

6.2.2 The transformer tank shall be bonded to the earth stud and to the substation earth bar.

6.2.3 The LV neutral of a transformer shall be bonded to the earth stud.

6.2.4 The earth stud shall be connected to the earth electrode.

6.2.5 All bonding and earthing conductors shall be of cross-sectional area at least 70 mm2 copper or equivalent, unless it can be shown by calculation that a smaller cross-sectional area will suffice.

6.2.6 Earthing terminations shall be installed individually and in such a way that they can easily be accessed and disconnected for routine earth testing.

6.2.7 The neutral earth resistance shall not exceed 1 Ω.

6.3 Installation of overhead structures

During erection the loading at critical points shall not compromise the safety of construction personnel.

6.4 Installation of transformers

6.4.1 On delivery, transformers shall be inspected for damage to cooling fins, bushings and peripheral devices.

6.4.2 When transformers are installed, it shall be ensured that the structure shall be capable of continuously bearing the load without sagging or subsiding.

6.4.3 The installer shall ensure that rigging operations are performed by a person who is deemed competent.

6.4.4 Transformers installed on pole structures shall be declared safe by the registered person after installation.

6.5 Installation of metal-enclosed switchgear

Metal-enclosed switchgear shall be electrically bonded with an earth conductor in accordance with SANS 62271-200.

6.6 Installation of power cables

6.6.1 Power cables shall be installed in accordance with SANS 10198.

NOTE SANS 10198 consists of multiple parts, each covering an aspect of the selection, handling and installation of electric power cables. Parts 1 to 5 deal with factors to be taken into account when an electrical distribution system is being designed.

6.6.2 To avoid any damage to the cable, the laying operations shall be performed at the ambient temperature specified by the equipment standard or by the manufacturer.

6.6.3 Single-core insulated cables shall be laid and secured in such a way as to ensure that the forces that result from short-circuit currents do not cause damage.

6.6.4 The method of laying cables shall be chosen to ensure that external effects are limited to acceptable safe values. In addition, when cables are being buried in troughs, they shall be installed at a specific depth and covered by slabs or a warning tape to warn of their presence.

6.6.5 Cables installed in earth trenches shall be laid on a bedding of sand or soil free of stones, and covered with the same material to a depth of at least 100 mm. Special constructions of cables can be chosen, if necessary, to protect against chemical effects. Cable routes shall be identified with cable route markers.

6.6.6 Measures shall be taken to prevent cables in troughs from being damaged by vehicles that run over them. Ground movements and vibrations shall be taken into account.

6.6.7 In the case of vertical installations, suitable cleats shall support the cable at intervals determined by the cable construction and by information provided by the manufacturer.

6.6.8 Cables installed in metallic pipes shall be grouped in such a way that the conductors of all phases (and neutral) of the same circuit are laid in the same pipe to minimize eddy currents.

6.6.9 Conductors and cables shall be arranged in such a way as to assure a safe insulation level between the conductors or cables and surrounding earthed metallic structures.

6.6.10 Where MV cables can be misidentified, they shall be clearly identified and along routes at every 5 m.

6.7 Installation of surge arresters

6.7.1 When surge arresters are being installed, they shall be installed in such a way that, in the event of failure, they will not be likely to endanger the lives of persons who perform operation or maintenance work.

6.7.2 Earth conductors shall be a minimum cross-section of 25 mm2, shall be routed such that they will not be prone to damage, and the shortest possible route to the earth bar or the earth terminal shall be arranged (see SANS 10292).

6.7.3 The earth resistance shall not exceed 10 Ω.

6.8 Installation of power capacitors

Effective earthing arrangements shall be in accordance with the requirements of SANS 10199.

6.9 Installation of generating machines

6.9.1 Exposed movable parts of generating machines shall be covered.

6.9.2 The enclosure of the generating machine shall be earthed at the point of installation.

6.10 Power line crossings

Crossings of roads and railways shall be performed in accordance with legislation .

6.11 Protection against leakage of insulating liquid

6.11.1 Measures shall be taken to contain any leakage from liquid-immersed equipment to prevent environmental damage.

6.11.2 The quantity of insulating liquid in equipment, any volume of water from rain and fire protection systems, proximity to watercourses and soil conditions should be considered in the selection of a containment system.

6.11.3 It shall be ensured that the capacities of sumps and catchment tanks for insulating and cooling fluids are not unduly reduced by water flowing in them. It shall be possible to drain or to draw off the water.

6.12 Installations that use SF6 as insulating medium

6.12.1 In rooms with SF6 installations, natural cross-venting through ventilation openings close to the ground is sufficient. Mechanical ventilation may be required in the case of insufficient ventilation.

NOTE Permanent ventilation may be omitted for chambers in installations that are not accessible.

6.12.2 Chambers, ducts, pits, shafts, etc. situated below SF6 installation rooms and connected to them shall be ventilated.

6.12.3 Where equipment is not sealed for life, SF6 gas shall be handled and retrieved in accordance with IEC 62271-303.

6.13 Notices, labels and rating plates

Notices, labels and rating plates shall be installed before commissioning of the installation in accordance with 4.4

7 Testing and measurement

7.1 Earthing system

Earthing systems and lightning protection systems for MV electrical installations shall be installed in accordance with SANS 10292 and SANS 10313 by a person who is deemed competent to perform earthing of electrical installations.

7.2 Testing of the fixed electrical installation

7.2.1 Before energizing, the engineering design, construction, composition of plant and equipment and protection systems of a medium-voltage electrical installation shall be declared safe and functional by the registered person (see the MV Installation Safety Report in annex B).

7.2.2 Inspections and tests shall be carried out to verify compliance of the installation with this part of SANS 10142 and compliance of the equipment with the applicable technical standards and specifications.

7.2.3 The following should be subject to agreement between the supplier and the user:

a) the extent of inspection and testing, if inspection and testing exceeding those in this part of SANS 10142 are required;

b) the extent and type of documentation provided, if documentation other than the documentation given in this part of SANS 10142 is required;

c) whether inspections and tests on parts of medium-voltage installations shall be carried out before delivery and energizing;

d) whether power distribution equipment shall be subjected to type tests for verification of performance characteristics.

7.2.4 Evaluation of full type-test reports shall be performed by a person who is deemed competent to determine the ability of equipment to comply with the designed system requirements.

7.2.5 The fixed electrical installation shall be subjected to full testing of

a) the earthing and bonding system,

b) interlocking,

c) earth switching,

d) mechanical testing, and

e) testing of all related protection and safety systems.

7.2.6 The registered person and the contractor's representative shall approve each part of the tests conducted and certify that the tests were carried out in accordance with the manufacturer's instructions and accepted MV installation practices.

7.3 Testing of transformers

7.3.1 Before commissioning, transformers shall be subjected to full routine tests in accordance with SANS 780.

7.3.2 The registered person shall verify the name plate of the transformer for authenticity.

7.3.3 Transformer oil shall be tested in accordance with SANS 555.

7.4 Testing of switchgear

Before energizing, switchgear shall be tested in accordance with the manufacturer's installation and testing instructions. The a.c. test voltages in table 5 apply.

Table 5 — Test voltages for circuit-breakers

1	2	3	4
Rated system voltage kV	**Test voltage between phase and earth** kV	**Test voltage across the contacts of the circuit-breaker** kV	**Test duration** min
3,3	8	10	1
6,6	16	18	1
11	22	26	1
22	40	48	1

7.5 Testing of cables

Before energizing, cables shall be tested in accordance with the requirements of the relevant part of SANS 10198.

7.6 Testing of batteries

Battery capacity shall be tested using a battery impedance tester and the results recorded in the test report for future maintenance purposes.

8 Commissioning

8.1 Commissioning of the fixed MV installation shall be recorded in a pre-determined plan and submitted to the registered person and to the user's designated person for approval in writing.

8.2 The registered person shall be present throughout the complete commissioning process. He shall ensure that the user is fully informed of all safety requirements applicable to the MV fixed electrical installation.

8.3 Phasing of circuits shall be performed with a phase comparator that complies with the requirements of SANS 61481.

9 Documentation

9.1 Design stage

9.1.1 The registered person shall submit the complete design and contract specification in writing to the contractor indicating his duties and responsibilities in terms of legislation (see foreword) pertaining to construction work. The contractor and the registered person shall sign the contract documentation in full.

9.1.2 The contractor shall indicate any visible safety deviations to the registered person.

9.1.3 A full set of the specifications and all engineering drawings shall be kept on site in a readily available format throughout all stages of the project.

9.2 Type-test reports

Before installation, the contractor shall submit a set of valid type-test reports to the professionally registered person. Equipment shall not be installed without written approval of the registered person.

9.3 Routine test certificates

Routine test certificates of all relevant power distribution equipment shall be submitted and approved by the registered person before commissioning of the fixed MV electrical installation.

9.4 Contract completion stage

9.4.1 The contractor shall ensure that the contract is completed in accordance with the approved specification and the design drawings as prepared, extended, or modified by the registered person.

9.4.2 The contractor and the registered person shall sign the MV Installation Safety Report (see annex B).

9.5 As-built drawings

The contractor shall submit final as-built electrical and mechanical drawings of the complete fixed MV electrical installation on completion of the project.

9.6 Operational manuals

Three sets of operational manuals shall be compiled that indicate all required safety earthing and operational actions required for the safe and functional use of the MV fixed electrical installation.

9.7 Maintenance manuals

9.7.1 On completion of the project, the registered person shall ensure that all relevant power distribution equipment instruction and maintenance manuals are handed over to the user's designated person.

9.7.2 A maintenance logbook shall be provided by the contractor for recording all maintenance actions as recommended in the maintenance manuals.

10 Safety measures

10.1 General safety measures

Work in the vicinity of or on live parts, shall be carried out in accordance with the rules, procedures, work distances etc. as required by legislation .

10.2 Measures for protection against direct contact

The following types of protection are recognized:

a) protection by enclosure;

b) protection by barrier;

c) protection by obstacles;

d) protection by placing out of reach.

10.3 Prescribed safety operating equipment

10.3.1 Portable earthing equipment shall comply with the requirements of SANS 61230.

10.3.2 Safety clothing and gear shall be approved for live MV switching.

11 Specific requirements (Under consideration)

11.1 Residential complexes

11.2 Commercial complexes

11.3 Industrial complexes

11.4 Agricultural complexes

Annex A
(informative)

Appointment of competent persons in South Africa

OCCUPATIONAL HEALTH AND SAFETY ACT, 1993 (Act No. 85 of 1993) (OHS Act)

A.1 Regulation 2 of the General Machinery Regulations – Supervision of machinery

In order to ensure that the provisions of the OHS Act and Regulations in relation to machinery are complied with, an employer or user of machinery shall, in writing, designate a competent person in a full-time capacity in respect of every premises on which machinery is being used.

The competency is determined by the sum of the power generated by machinery on the premises and the power derived from other sources (including the generation of steam), and the provisions in A.2 to A.4 apply.

A.2 Up to and including 1 200 kW

A.2.1 The person

a) shall have served an apprenticeship in an appropriate engineering trade including the operation and maintenance of machinery, or

b) shall have had at least five years practical experience in the operation and maintenance of machinery.

A.2.2 The person shall have experience of which at least one year's experience shall be on the type of machinery he or she is required to supervise.

A.3 Above 1 200 kW but less than 3 000 kW

A.3.1 The person shall have obtained an engineering diploma in either mechanical or electrical engineering (heavy current), or the equivalent.

A.3.2 The person shall have at least two years practical experience (post qualification) in the operation and maintenance appropriate to the class of machinery he or she is required to supervise.

A.4 3 000 kW and above

A.4.1 A graduate engineer.

A.4.2 The person shall have at least two years practical experience (post-graduate) in the operation and maintenance appropriate to the class of machinery he or she is required to supervise, and shall have passed the examination on the Act as held by the relevant authority (see foreword).

A.4.3 A certificated engineer.

A.5 Power levels

Where the machinery is solely for the distribution of electricity, the power levels are respectively

a) up to 3 MVA,

b) 3 MVA but less than 10 MVA, and

c) 10 MVA and above.

Annex B
(normative)

MV Installation Safety Report

B.1 Safety report issued by the contractor's representative and, where applicable, by the professionally registered person

B.1.1 Declaration

I (FULL NAME IN BLOCK LETTERS), ..., the appointed Registered Person, Professional Registration Number with the Engineering Council of South Africa, No.:……., Physical address: ...., Telephone No.: …….…… Cellular No.: ....., declare that I have designed and/or inspected and witnessed the performance and acceptance testing of the MV installation as indicated under items B.1.2, B.1.3 and B.2.1 to B.2.5 in accordance with SANS 10142-2 and that the installation is safe for operation as intended.

SIGNATURE:.....

DATE: .....

I (FULL NAME IN BLOCK LETTERS), ..., Representative of the Contractor (Contractor's name): ....., Business Registration: ....., Registration Number as an Electrical Contractor (Electrical Installation Regulations): ....., Telephone No.: ……..……, Cellular No.: ....., declare that the installation was installed in accordance with SANS 10142-2 and that I have inspected and arranged for the performance and acceptance testing of the installation as indicated under items B.3.1 to B.3.6 below and that the installation is safe for operation as intended.

SIGNATURE:.....

DATE: .....

MV Installation Safety Report *(continued)*

B.1.2 Location

Physical address: .....

.....

Stand number: .....

Name of building: .....

Name of farm: .....

Number of farm: .....

Township/Municipality/District: .....

Supplier: .....

B.1.3 Installation

Existing certificate No ☐ Yes ☐ Date issued ..... No. .....

Existing installation ☐ Alteration/Extension ☐ New installation ☐

Estimated year of original installation .....

Type of installation:

Domestic ☐ Commercial ☐ Industrial ☐ Agricultural ☐

Supply voltage: 3,3 kV ☐ 6,6 kV ☐ 11 kV ☐ 22 kV ☐

Other .....

Current rating: ..... A Short-circuit withstand rating: ..... MVA, …. s

Brief description of work:

(use separate page(s) if desired) .....

.....

.....

.....

.....

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.....

.....

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MV Installation Safety Report *(continued)*

B.2 Registered person — Design, supervision and witness testing

Mark each question with "Y", "N" or "N/A" and initial in the appropriate space alongside.

B.2.1 Equipment of the new, extended or reconstructed installation

		Clause	Y/N/ N/A	Initial
a)	Do the components specified comply with the applicable standards listed in table 1?	4.3		
b)	Have all the components been type tested to the applicable standards by an SANS 17025 accredited test house?	9.2		
c)	Are the type-test reports still valid?	9.2		
d)	Have the designs of components not covered by type-test reports been verified by the registered professional person?	9.2		
e)	Where refurbished equipment is installed, was it routine tested in accordance with the original standard requirements?	9.3		
f)	Are applicable routine test reports available for the components of the new, extended or rewired installation?	9.3		
g)	Are adequate facilities provided for handling of toxic substances?	6.11 and 6.12		
h)	Are equipment operating and maintenance instructions available on site?	9.6 and 9.7		
i)	Do the minimum clearances in air between live parts and between live parts and earth comply?	5.5.3		
j)	Are the conductors of the correct current-carrying capacity?	5.1.7.1		
k)	Is the installation suitable for the local environmental conditions such as humidity, salt spray, solar radiation, ambient temperature, seismic conditions, wind, etc?	5.7.1		
l)	Is the installation protected by a circuit-breaker that will automatically isolate the installation at the point of control under fault conditions?	5.8		
m)	Are disconnecting devices correctly located with respect to accessibility for switching and maintenance purposes?	5.8		
n)	Are different circuits separable electrically to prevent backfeed?	5.1.1.4		
o)	Are the connections of all conductors, including earthing and bonding, mechanically sound and electrically continuous?	6.2		
p)	Have power frequency tests to specified test limits been performed on all main circuits?	7.4		
q)	Has the phasing of all circuits been performed?	8.3		
r)	Are power cables of different voltages, control and communication cables correctly separated?	5.1.7.3		
s)	Have the correct fault rating, co-ordination and certification of fuses been verified?	5.8		
t)	Have the appropriate short-circuit ratings and performance ratings of switchgear been verified?	5.1.5		

B.2.2 Protection design and settings

a)	Has a schedule of all protection settings been provided?	5.8		
b)	Has surge protection been correctly designed and installed?	5.1.8		
c)	Is the battery supply for system protection, where applicable, of sufficient capacity?	5.1.6		

MV Installation Safety Report *(continued)*

B.2 Registered person — Design, supervision and witness testing

Mark each question with "Y", "N" or "N/A" and initial in the appropriate space alongside.

d)	Have all protection, alarm and indicating devices been commissioned? (e.g. Buchholz, oil temperature, overcurrent and earth-fault relays, counters, auto-reclosers, max. demand indication, etc)	5.8		
e)	Where metering is provided, are the correct class and ratio of CTs provided?	5.1.4.3 and 5.10.12		

B.2.3 Substation design and construction

a)	Are accesses and emergency exits visible at all times, marked and operational?	5.10		
b)	Is perimeter fencing correctly positioned, secure against unauthorized entrance and bonded to the earth mat?	5.6		
c)	Are locks and keys of good quality at hand for all controlled entrances?	5.6		
d)	Is adequate ventilation provided for cooling?	5.7		
e)	Is the lighting, for both normal and emergency operations, in accordance with prescribed levels?	5.4		
f)	Are there separation barriers and distances between MV and LV to specified requirements?	5.4.4		
g)	Is access to live parts sufficiently prevented?	5.5.1.5 and 5.1.1.1		
h)	Is drainage functional and adequate?	5.4.1		
i)	Are notices, safety signs, marking and labelling in accordance with the prescribed requirements?	4.4 and 5.10		
j)	If it is required, does the fire fighting equipment comply with the local fire regulations	5.1.2.9		
k)	Has a logbook been provided for all events and switching?	9.7.2		
l)	Where applicable, have interlocking and lock-out facilities been provided?			
m)	Are laminated general arrangement and circuit diagrams on prominent display?	9.5		
n)	Have all other potentially pollutant services been excluded from substations?			
o)	Where necessary, is the installation protected against damage by road and process vehicles?			

B.2.4 Transformer

Is the oil sump adequately designed and positioned away from the transformer?	5.1.2.10		

B.2.5 Earthing

a)	Is the MV / LV earthing configuration in accordance SANS 10292?	5.3.2		
b)	Is the earth electrode, if present, designed in accordance with SANS 1063?	7.1.1		
c)	If a dedicated earth bar is installed, is it of the correct cross-sectional area?	5.3.7		
d)	If applicable, is type tested portable earthing gear available and well maintained?	10.3.1		
e)	Where substation earthing is provided, is each point accessible and indicated?			

MV Installation Safety Report *(continued)*

B.3 CONTRACTOR — Procurement, installation, testing and commissioning

Mark each question with "Y", "N" or "N/A" and initial in the appropriate space alongside.

B.3.1 Equipment of the new, extended or reconstructed installation

		Clause	Y/N/ N/A	Initial
a)	Do the components used comply with the applicable standards given in the table 1?	4.3		
b)	Are components, which are not covered by type-test reports, listed in an attached schedule?	4.3		
c)	Are applicable routine test reports available for the components of the new, extended or rewired installation?	9.3		
d)	Have all the components been correctly selected and installed for the application?	4.3		
e)	Has all visible damage to components, if present, which will not compromise the safety of the installation, been listed on the attached schedule?	4.3		
f)	Have fire barriers been installed, such as sealing of trenches and ducts, or have other precautions been taken against the spread of fire or the harmful effects of heat?			
g)	Does the installation comply with the local fire regulations?	5.1.2.9		
h)	Is all oil free of CFCs?	5.1.4.1.2		
i)	Are equipment operating and maintenance instructions available on site?	9.7.1		
j)	Do the minimum clearances in air between live parts and between live parts and earth comply?	5.5.1.1		
k)	Are the connections of all conductors, including earthing and bonding, mechanically sound and electrically continuous?	7.1.1		
l)	Have circuits and components such as fuses, switches, terminals, fault protection devices, circuit-breakers, control switches, etc., been permanently marked or labelled?	5.10.8		
m)	Have power frequency and a.c. tests to the specified test limits been performed on all main circuits?	7.4		
n)	Has the phasing of all circuits been performed?	8.3		
o)	Are power cables of different voltages, control and communication cables correctly separated?	5.1.7.3		

B.3.2 Protection design and settings

a)	Has a schedule of all protection settings been provided?	5.8		
b)	Has surge protection been correctly designed and installed?	5.1.8		
c)	Have all protective, alarm and indicating devices been commissioned? (e.g. Buchholz, oil temperature, overcurrent earth-fault relays, counters, auto-reclosers, max. demand indication, etc.)	5.8		
d)	Where metering is provided, are the correct class and ratio of CTs provided?	5.1.4.3 and 5.10.12		

B.3.3 Substation design and construction

a)	Are accesses and emergency exits visible at all times, marked and operational?	5.10		
b)	Is perimeter fencing correctly positioned, secure against unauthorized entrance and bonded to the earth mat?	5.6		

MV Installation Safety Report *(continued)*

B.3 CONTRACTOR — Procurement, installation, testing and commissioning

Mark each question with "Y", "N" or "N/A" and initial in the appropriate space alongside.

c)	Are locks and keys of good quality at hand for all controlled entrances?	5.6		
d)	Are there separation barriers and distances between MV and LV in accordance with specified requirements?	5.4.4		
e)	Is access to live parts sufficiently prevented?	5.5.1.5 and 5.1.1.1		
f)	Is drainage functional and adequate?	5.4.1		
g)	Are notices, safety signs, marking and labelling in accordance with the prescribed requirements?	4.4 and 5.10		
h)	If it is required, does the fire fighting equipment comply with the local fire regulations?	5.1.2.9		
i)	Has a logbook been provided for all events and switching?	9.7.2		
j)	Where applicable, have interlocking and lock-out facilities been provided?			
k)	Are laminated general arrangement and circuit diagrams on prominent display?	9.5		
l)	Is the wiring of the building's low-voltage installation in accordance with SANS 10142-1?			

B.3.4 Transformer

a)	Has the quality of the oil been verified by sampling and testing in accordance with SANS 555?			
b)	Are the silica gel breathers filled and dry (blue)?			
c)	Are the bushings SANS 60137 compliant?	5.1.4.2.4		
d)	Are all distribution transformers free of visible oil leaks?			

B.3.5 Earthing

a)	Is the MV / LV earthing configuration in accordance SANS 10292?	5.3.2		
b)	If a dedicated earth bar is installed, is it of the correct cross-sectional area?	5.3.7		
c)	If applicable, is type-tested portable earthing gear available and well maintained?	10.3.1		
d)	Where substation earthing is provided, is each point accessible and indicated?			

MV Installation Safety Report *(concluded)*

B.3 Contractor — Procurement, installation, testing and commissioning

B.3.6 Tests carried out, and instruments used (additional schedules to be submitted, where applicable)		**Measurement and accuracy**
a) Continuity and resistance of earth conductor including all bonding conductors:		
	Instrument:	
b) Continuity of ring circuit:		
	Instrument:	
c) Earthing system impedance:	Earth resistivity (RE):	
	Earth impedance (ZE):	
d) Earth electrode resistance:		
	Instrument:	
e) Insulation resistance:		
	Instrument:	
f) Phase rotation and phasing:		
	Instrument:	
g) Earth fault loop impedance test:		
	Instrument:	
h) High-voltage testing of cables to SANS 10198-13		
i) Injection tests for protection settings performed		
j) Tests of:	Protection relays:	
	Monitoring relays:	
	Measuring relays:	
	Interlocking and lock-out devices:	

Instruments used were calibrated either by a National Accredited Laboratory traceable to NCS Standards, or using instruments that were calibrated by a National Accredited Laboratory traceable to NCS Standards.

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